Important Elements in Gluten-Free Bread Making

Oksana V. Moshynska

Marshall School of Business, University of Southern California

Author Note

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Correspondence concerning this article should be addressed to Oksana V. Moshynska, Head Librarian and Branch Manager, North Battleford Public Library, 1392 – 101 Street, North Battleford, Saskatchewan, S9A 1A2, Canada. E-mail: oksana.moshynska@usask.ca

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People with celiac disease who rely on food industry to supply them with gluten-free food are currently in vulnerable position due to the COVID-19 pandemic announced by the World Health Organization (2020a) on March 11, 2020. The second COVID-19 wave in the North America (Higgins-Dunn, 2020; World Health Organization, 2020b) resulted in shut down of many businesses including restaurants, forcing those struggling with celiac disease to seek gluten-free food elsewhere (Attet, 2020; Schnalzer, 2020; Soloducha, 2020). In addition, there is a noted and steady (since 1980) increase in home cooking trend; home cooks including affected with celiac disease turning online for gluten-free bread recipes (Close-Up Media, 2012).

Celiac disease is an autoimmune chronic disease caused by inability to process gluten proteins mostly found in wheat, rye, and barley (Sollid, & Lundin, 2014). People affected by celiac disease that is often accompanied by other autoimmune diseases such as type I diabetes, dermatitis herpetiformis, Sjogren's syndrome, Hashimoto's thyroiditis, etc., found to benefit from gluten-free diet (Balaceanu et al., 2020; Mormile, 2016; Szodoray et al., 2003; Thawani et al., 2017). This disease affects 1:130 to 1:300 people in Europe and the United States (Mustalahti et al., 2010). There are about 3 million people in the United States diagnosed with celiac disease (Zhang, 2016). This disease is most prevalent in female Caucasians; its prevalence increased 4-5 times in the last 50 years (Mustalahti et al., 2010; Sollid, & Lundin, 2014; Zhang, 2016).

The only existing most effective treatment for celiac disease is avoiding eating foods with gluten (Moroni, 2009). This, however, is not an easy task as, together with milk, bread is an essential food (Bulfinch, 2013). Because bread is mostly made from flours consisting gluten (e.g., wheat, rye), those with celiac disease are unable to consume it (Sollid & Lundin, 2014). The bread is a universal food with a high nutritional value that is composed of complex carbohydrates, fiber, vitamin B, iron, and calcium (Cavaoani, 1993). However, bread making from gluten flours present major challenges to food technologists (Moroni, 2009). The gluten binds and keeps all bread ingredients together and without it, the dough usually does not rise and is hard to handle, and the baked bread has poor taste and smell qualities, is pale in color, and cannot be stored for prolonged time (Masure, et al., 2016). Many gluten-free bread recipes are identified as of low quality and poor characteristics when it comes to its taste, crumb and crust texture, feel, flavor, and smell (Galagher et al., 20014).

Among most common studied characteristics of gluten-free breads are bread texture (73%), visual analysis (50%), and sensory feeling (27%) (Masure et al., 2016). An analysis of peoples' preferences for gluten-free bread's features such as appearance, aroma, flavor, crumb, softness, and overall look (de Morais et al., 2013) suggested a higher preference for a "higher specific volume and lower firmness, elasticity and chewiness" (p. 2183). Despite the growing need for gluten-free bread, there is a limited peer-reviewed information available on the topic and ideal properties of a gluten-free bread are yet to be identified (Masure, et al., 2016, p. 106).

The hypothesis of this study is that people use common patterns in their gluten-free bread-making decisions. The objective of this study was to identify influencing factors in deciding whether a gluten-free bread recipe was a good one.

Method

Sample

The content analysis sample was composed of 106 reviews written between November 6, 2012 and November 25, 2020. The sample covers the reviews of the gluten-free bread recipe (E., C., 2012). One reviewer who did not try the bread was excluded from the analysis.

Procedure

The reviews were rated by three raters (with each rater single coding 1-3 variables), who were trained in the operationalization of variables and in the coding procedures. A total of seven variables were coded as described in the Appendix A. These variables were grouped into three subsections, Performance, Quality, and Suggested Improvements.

The first section coded for, Performance, consisted of three variables. These variables were Star Rating, Number of Words, and Overall Bread Satisfaction. The first of these variables, Star Rating, was referred to the 1 to 5 stars that each reviewer awarded to the recipe on the website. The second variable coded for was Number of Words in each review. The third of these variables, Bread Satisfaction, was defined via a 7-point Likert scale, ranging from “extremely dissatisfied” to “extremely satisfied,” as the overall satisfaction with the gluten-free bread’s finished product. Examples of this included, but not limited to, the product’s overall impression and baking experience, such as “horrible,” “delicious,” “a keeper,” and “magnificent.”

The second section coded for, Quality, consisted of two variables. These variables were Texture and Taste. The first variable, Texture, was defined via a 7-point Likert scale, ranging from “very poor” to “excellent,” as to what extent the reviewer liked the texture of the baked gluten-free bread. Examples of this included “crumbly,” “dense,”, “raw,” “dry,” “crunchy,” “airy,” “fluffy,” “spongy.” The second of these variables, Taste, was defined via a 7-point Likert scale, ranging from “very poor” to “excellent,” as to what extent the reviewer liked the taste of the product. Examples of this included “delicious,” “soft,” “chewy.”

The third section coded for, Suggested Improvements, consisted of two variables. These variables were Traditional Bread Comparison and Modification. The first of these variables, Traditional Bread Comparison, was defined via a 7-point Likert scale, ranging from “extremely dissimilar” to “extremely similar,” as the reviewer’s perception of the gluten-free being close to ‘traditional’ bread made using wheat flour (which contains gluten). Examples of this included, but not limited to, the product’s density, crust, taste, and color: “strange,” “different,” “eggy,” “normal,” “traditional.” The second of these variables, Modification, was defined via a 7-point Likert scale, ranging from “major modifications” to “no modifications,” as to what extent the reviewer changed the recipe to suit their personal tastes. Examples of these included, but not limited to, the substituted single, several, or multiple ingredients, and cooking settings.

Results

This content analysis revealed among the 106 reviews of the gluten-free bread, the majority (76.4%) gave it a 5-star review and 15.1% gave it a 4-star review. People in general reported the gluten-free recipe was good by assigning a higher star rating ($M = 4.61$, $SD = 0.85$). A one-sample t test indicated that this mean value was significantly different from the midpoint (neutral value of 3.0), $t(105) = 19.63$, $p < .001$. Reviewers in general were satisfied with the recipe ($M = 6.36$, $SD = 1.45$). A one-sample t test indicated that this mean value was significantly different from the midpoint (neutral value of 4.0), $t(105) = 16.76$, $p < .001$. There was also a significant strong positive relationship found between star rating and bread satisfaction ($r = .71$, $p < .001$). There was non-significant positive relationship found between star rating for the recipe and number of words in a review ($r = .01$, $p = .913$).

People in general agreed the bread was comparable with a traditional bread ($M = 4.45$, $SD = 1.59$). A one-sample t test indicated that this mean value was significantly different from the midpoint (neutral value of 4.0), $t(105) = 2.94$, $p = .004$. A significant positive correlation was found between star rating and comparison to a traditional bread ($r = .51$, $p < .001$).

People in general reported their liking of the bread’s texture ($M = 5.30$, $SD = 1.73$). A one sample t test indicated that this mean value was significantly different from the midpoint (neutral value of 4.0), $t(105) = 7.77$, $p < .001$. There were significant positive relationships found between people liking the texture of the bread and star rating ($r = .36$, $p < .001$), perception of being satisfied with the bread ($r = .44$, $p < .001$), liking the taste of the bread ($r = .41$, $p < .001$), and thinking it is comparable to a traditional bread ($r = .57$, $p < .001$).

People in general reported their liking of the bread's taste ($M = 6.46$, $SD = 1.31$). A one sample *t* test indicated that this mean value was significantly different from the midpoint (neutral values of 4.0), $t(105) = 19.34$, $p < .001$. There were significant positive relationships between people liking the taste of the bread and star rating ($r = .64$, $p < .001$), and its comparability to a traditional bread ($r = .45$, $p < .001$).

A paired-samples *t* test was conducted to determine if people were more concerned with the bread's resemblance to a traditional bread or its texture. The results indicated the mean concern for the texture ($M = 5.30$, $SD = 1.73$) was significantly higher than the mean concern for its resemblance to a traditional bread ($M = 4.45$, $SD = 1.59$), $t(105) = -5.69$, $p < .001$.

A paired-samples *t* test was conducted to determine if potential cooks were more concerned with the bread's texture or taste. The results indicated the mean concern for the gluten-free bread's taste ($M = 6.46$, $SD = 1.31$) was significantly greater than the mean concern for the bread's texture ($M = 5.30$, $SD = 1.73$), $t(105) = 7.07$, $p < .001$.

Discussion

This study has identified peoples' satisfaction with this recipes' gluten-free bread, and this enjoyment was demonstrated by both assigning as a higher star rating to the recipe and showing the overall satisfaction with the bread. People's satisfaction with the bread were influenced by several factors including the bread's resemblance to a traditional (gluten) bread, its appearance, taste, and texture. These results are similar to the conducted by de Morais et al.'s

(2013) study, in which peoples' preferences were higher for the combined bread's texture and crunchiness features (p. 2183). The examination of the gluten-free bread's individual features (its comparison to a traditional bread, texture, and taste) demonstrated the importance of these factors in the following order: taste, followed by texture and then by its resemblance to a traditional bread. These results are in agreement with "taste and mouthfeel are key to bread quality" conclusion made by Masure et al. (2016).

It would be beneficial to test the findings of this study on other recipe reviews and to analyze other bread's features such as its aroma, longevity, and visual characteristics. Identified in this study important qualities of gluten-free bread, which are of relevance to celiac people, have a potential value for gluten-free food industry, food-policy makers, and home cooks interested in gluten-free bread making.

References

Atter, H. (2020, August 13). Regina restaurant shuts down again after spike in local COVID-19 cases. *CBC News*. https://www.cbc.ca/news/canada/saskatchewan/regina-restaurant-shuts-down-again-after-spike-in-local-cases-1.5685033

Bulfinch, A. (2013, February 27). Essential food shopping always precedes a big storm: Bread and milk are hot commodities. *Knight-Ridder/Tribune Business News*. https://www.fosters.com/article/20130227/gjnews_01/130229344

Cavaiani, M. (1993, September-October). Bread is often overlooked as an essential food. *Diabetes in the News*, *12*(5), 34. https://link.gale.com/apps/doc/A14276001/AONE?u=usocal_main&sid=AONE&xid=0a460da3

Close-Up Media. (2012, November 24). Zagat survey: Cooking at home outpacing going out for meals. *Entertainment Close-up*. https://link.gale.com/apps/doc/A309736606/BIC?u=usocal_main&sid=BIC&xid=29afb9a1

de Morais, C., Carvalho, E., Gomez, A., & Bolini H. (2013). Gluten-free bread: Multiple time–intensity analysis, physical characterization and acceptance test. *International Journal of Food Science & Technology*, *48*(10), 2176–2184. https://doi.org/10.1111/ijfs.12202

E., C. (2012). Wonderful gluten free white bread. All Recipes. Retrieved November 30, 2020, from https://www.allrecipes.com/recipe/229878/wonderful-gluten-free-white-bread/

Gallagher, E., Gormley, T., & Arendt, E. (2004). Recent advances in the formulation of gluten-free cereal-based products. *Trends in Food Science & Technology, 15* (2004), 143-152. https://doi.org/10.1016/j.tifs.2003.09.012

Higgins-Dunn, N. (2020, October 14). WHO warns Canada is facing a 'second wave' of coronavirus cases. *CNBC*. https://www.cnbc.com/2020/10/14/who-warns-canada-is-facing-a-second-wave-of-coronavirus-cases-.html

Masure, H., Fierens, E., & Delcour, J. (2016). Current and forward looking experimental approaches in gluten-free bread making research. *Journal of Cereal Science*, *67*, 92–111. https://doi.org/10.1016/j.jcs.2015.09.009

Mormile, R. (2016). Celiac disease and Hashimoto's thyroiditis: A shared plot? *International Journal of Colorectal Disease*, *31*(4), 947. doi:http://dx.doi.org.libproxy1.usc.edu/10.1007/s00384-015-2370-z

Moroni, A., Dal Bello, F., & Arendt, E. (2009). Sourdough in gluten-free bread-making: An ancient technology to solve a novel issue? *Food Microbiology, 26*(7), 676-684. https://doi.org/10.1016/j.fm.2009.07.001

Mustalahti, K., Catassi, C., Reunamen, A., Fabiani, E., Heier, M., McMillian, S., Murray, L., Metzger, M., Gasparin, M., Bravi, E., & Maki, M. (2010). The prevalence of celiac disease in Europe: results of a centralized, international mass screening project. *Annals of Medicine (Helsinki), 42*(8), 587-595. https://doi.org/10.3109/07853890.2010.505931

Schnalzer, R. (2020, October 29). COVID-19 devastated California's small businesses. Here are three that didn't survive. *Los Angeles Times*. https://www.latimes.com/business/story/2020-10-29/coronavirus-pandemic-small-business-southern-california

Sollid, L., & Lundin, K. (2014). Celiac disease. In N. R. Rose & I. R. Mackay (Eds.), *The autoimmune diseases* (5th ed., pp. 855-871). Elsevier Inc., https://doi.org/10.1016/B978-0-12-384929-8.00059-9

Soloducha, A. (2020, May 7). Many Sask restaurants might permanently close due to COVID-19. *CBC News*. https://www.cbc.ca/news/canada/saskatchewan/many-sask-restaurants-might-permanently-close-due-to-covid-19-1.5560661

Szodoray, P., Barta, Z., Lakos, G., Szakall, S., & Zeher, M. (2003). Coeliac disease in Sjögren's syndrome—a study of 111 Hungarian patients. *Rheumatology International*, *24*(5), 278–282. https://doi.org/10.1007/s00296-003-0360-x

Thawani, S., Brannagan, T., Thomas, H., Lebwohl, B., Mollazadegan, K., Green, P., & Ludvigsson, J. (2017). Type 1 diabetes, celiac disease, and neuropathy—a nationwide cohort study. *Journal of Clinical Neuromuscular Disease*, *19*(1), 12–18. https://doi.org/10.1097/CND.0000000000000174

World Health Organization. (2020a, March 11). WHO director-general's opening remarks at the media briefing on COVID-19 - 11 March 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

World Health Organization. (2020b, October 4). Coronavirus disease (COVID-19). https://www.who.int/docs/default-source/coronaviruse/situation-reports/20201005-weekly-epi-update-8.pdf

Zhang, H. (2016). The skin of celiac disease: Systematic review and pooled analysis: 1097. *The American Journal of Gastroenterology*, *111*, S479–S480. https://doi.org/10.14309/00000434-201610001-01097

Appendix A: Coding Dictionary

Number_of_Words is a manifest code that measures the number of words that appeared in each review.

Star_Rating is a manifest code that refers to the 1-5 stars that the reviewer awarded to the specified recipe on Allrecipes.com. These ratings were clearly indicated above each review on the webpage.

Bread_Satisfaction is a latent code that measured how satisfied the reviewer was with the gluten-free bread's flavor and the reviewer's overall satisfaction with the finished product.

Keywords:

Dissatisfied	Satisfied
Horrible, too sweet, too salty, dry, very liquidly, no taste, aftertaste	Delicious, a keeper, great taste, worth a shot, awesome, wonderful, fantastic, excellent, magnificent, nice, smells lovely

Examples:

1. Extremely dissatisfied: "I tried this recipe twice to the letter and my bread turned out horrible. It...overall looked like a child did it." "It was very liquidly, didn't rise while baking and was stale feeling and tasting."
2. Dissatisfied: "What I do NOT like about the bread made from this recipe is- 1) taste. (whole) eggs change the flavor from 'bread' to more cake like..." "Turns out more like pound cake than bread. Maybe too much water or oil. Bread deflated after coming out of oven." "The taste isn't wonderful." "It looked good toasted nicely but had no taste. I will not make it again."

3. Slightly dissatisfied: “I also don’t care for the after taste...All in all, decent recipe.” “For being homemade, I guess I just expected something so much better...This one was so sweet it almost reminded me of a mix between bread and a low sugar pound cake…”
4. Neutral or no commentary on the subject.
5. Slightly satisfied: “The bread doubled just fine and baked up nicely without collapsing. However, I found it a little dense and crumbly.” “It came out beautifully...However, I would not consider it a pure replacement for white bread.”
6. Satisfied: “Good taste! A little dense, don’t know if that is normal or not, but still tastes good!” “I thought the taste was pretty good.” “A little on the sweet side…” “Nice bread, just a little too sweet for my taste.”
7. Extremely satisfied: “Simply delicious.” “It is AWESOME!” This was wonderful!” “A little piece of heaven in this recipe..It was moist rose beautifully and tasted sooo good!” “This bread came out absolutely delicious!” “Awesome recipe!!!!! Great taste...” “This is a keeper!” “Absolutely delicious!! Great gluten free texture waaaay better than store bought breads. I dare say it’s better than traditional white bread!” “This is it!!!!!...it will be treasured by my growing family of 8.” “This recipe is FANTASTIC.” “This gf bread is sublimely delicious! WHY WHY WHY haven’t I been doing this all along?” Awesome recipe!...OMG! Good!!” “This is hands down my most favorite gf bread ever!!!! Now the most important part for me it’s not dry and doesn't; feel like it’s sucking all the moisture from your body while you try to choke it down.” “It is absolutely delicious-moist, soft with a slightly crunchy crust, and full of air pockets.”

7-point scale coding: 1 = Extremely Dissatisfied, 2 = Dissatisfied, 3 = Slightly Dissatisfied, 4 = Neutral or Silent, 5 = Slightly Satisfied, 6 = Satisfied, 7 = Extremely Satisfied

Traditional_Bread_Comparison is a latent code that quantified to what extent the reviewer felt the gluten-free bread they made using the recipe was similar to "traditional" bread made using wheat flour (which contains gluten). Reviewers most frequently cited the consistency, crust, and density of the bread when drawing comparisons to "traditional," glutinous bread.

Keywords:

Dissimilar	Similar
Dense, crumbly, tough, hard, wet, dry, eggy, heavy, strange, different	Airy, chewy, fluffy, crunchy, spongy, regular, normal, traditional

Examples:

1. Extremely Dissimilar: "It was incredibly dense - almost the consistency of biscuits."
2. Dissimilar: "This recipe - while easy and quick to make - produces a more cake like type of texture that reminds me of pound cake more than bread." "Turns out more like pound cake than bread."
3. Slightly Dissimilar: "I found it a little dense and crumbly."
4. Neutral or no commentary on the subject
5. Slightly Similar: "This has the look and texture of the gluten free breads I have tasted such as Udi's brand. It is just slightly more dense."
6. Similar: "It is dense as others have mentioned but has really lovely air pockets like you get with wheat bread."
7. Extremely Similar: "The texture is wonderful! It's as close to traditional bread as I've had since I going gluten free" "Really impressed with how much it tasted like buns with gluten."

7-point scale coding**:** 1 = Extremely Dissimilar, 2 = Dissimilar, 3 = Slightly Dissimilar, 4 = Neutral or No Commentary, 5 = Slightly Similar, 6 = Similar, 7 = Extremely Similar

Modification is a latent code that quantified to what extent the reviewer changed the recipe to suit their personal tastes. Reviewers most frequently cited they liked the recipe as is, that they would make a modification in the future, or they substituted multiple ingredients.

Keywords: substituted, as written, changed, followed, modified

Modified Recipe	Neutral	Recipe as Written
4 or more modifications	No comment on if they made changes or not	No modifications

Examples:

1. Major modification: “Using my own flour blend 2 white rice 1 each potato starch tapioca flour I found this recipe to be the best! (I avoid sorghum..) I also use butter and coconut oil for fats. Add the juice and rind of half a lemon.”
2. Dissimilar: “added some jalapeños along with garlic powder basil oregano and onion.” powder,” “modify with grain additions like sunflower seeds flax seeds and gluten free rolled oats.”
3. Slightly Dissimilar: “using my 9 cup food processor,” “warming the oven…and leaving the brad in the oven for an hour.”
4. Neutral “I followed it exactly with the exception of using fast rising yeast.”
5. Slightly Similar: “made it in my bread maker” and “used GF all purpose flour,” “used brown rice flour.”
6. Similar: “the only change I made was coconut oil in place of vegetable oil.”
7. As written: “I followed the recipe exactly and changed absolutely nothing....it's perfect the way it is.”

7-point scale coding: 1 = Major Modifications, 2 = Dissimilar, 3 = Slightly Dissimilar, 4 = Neutral, 5 = Slightly Similar, 6 = Similar, 7 = No Modifications

Texture is a latent code that quantified to what extent the reviewer liked the texture of the baked gluten-free bread.

Keywords:

Very poor	Excellent
Crumbly, tough, dense, raw, wet, dry, heavy	Crunchy, airy, fluffy, spongy

Examples:

1. Very poor: “I got to the center of the loaf and found it was raw.” “It was holey and lumpy and not a nice texture at all.” “It was incredibly dense.” “It was very-very dense and somewhat wet in the middle.”
2. Fair: “Too crumbly.” “My issue with it is that it doesn’t rise well-it makes a very dense loaf.”
3. Below average: “The texture was slightly denser than wheat bread but not that noticeable.” “Just a bit dry.” “A little dense and crumbly.”
4. Average: Neutral or no commentary on the subject.
5. Above average: “Soft and chewy.”
6. Good: ‘Nice and light and fluffy.” “Good texture.” “Good consistency.” “The bread raised beautifully nice and light and fluffy.”
7. Excellent: “It is absolutely delicious-moist, soft, with a slightly crunchy crust, and full of air pockets.” “The texture of the bread from this recipe is the best ever even by plain white bread standards.”

7-point scale coding: 1 = Very Poor, 2 = Fair, 3 = Below Average, 4 = Average, 5 = Above Average, 6 = Good, 7 = Excellent

Taste is a latent code that quantified to what extent the reviewer liked the taste of the baked gluten-free bread.

Keywords:

Very poor	Excellent
Isn’t wonderful	Delicious, great, soft, chewy, awesome

Examples:

1. Very poor: “It had no taste. I will not make it again.”
2. Fair: “Was stale feeling and tasting.”
3. Below average: “Had a strange after taste.” “Taste isn’t wonderful.”
4. Average: Neutral or no commentary on the subject.
5. Above average: “The taste was pretty good.”
6. Good: “Tastes like “normal” bread!” “Good taste!”
7. Excellent: “The bread came out absolutely delicious!” “Simply delicious.”

7-point scale coding: 1 = Very Poor, 2 = Fair, 3 = Below Average, 4 = Average, 5 = Above Average, 6 = Good, 7 = Excellent